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Technical Report

DIMINISHING PROTECTION FOUND IN FLOTATION-TYPE BALLAST-TANK PRESERVATIVES

3 December 1964

U. S. NAVAL CIVIL ENGINEERING LABORATORY

Port Hueneme, California

DIMINISHING PROTECTION FOUND IN FLOTATION-TYPE BALLAST-TANK PRESERVATIVES

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Type B Final Report

by

C. V. Brouillette

ABSTRACT

Samples of used rust-retarding, flotation-type, ballast-tank preservatives were taken from 30 floating drydocks to analyze their corrosion-resisting properties. After a few months' service inside the ballast tank of a floating drydock, these oils were found to fail the MIL-SPEC requirements for rust retardation. It was found that because of improper use of these oils, only about 20 percent of the drydocks were receiving as much as 80 percent reduction in corrosion.

INTRODUCTION

The U. S. Naval Civil Engineering Laboratory (NCEL) made a study of used rust-retarding, flotation-type, ballast-tank preservatives. Flotation protective oils used inside ballast tanks to retard corrosion rely upon corrosion inhibitors and other surface-active compounds for their effectiveness. These surface-active compounds have the property of concentrating at the interfaces between oil and steel or rust, oil and water, oil and air, oil and sand particles (including silt), and between oil and any other surface that forms an interface. At the interface, the corrosion-inhibiting molecule becomes oriented in such a way that a portion of the molecule extends into the oil, and the remaining portion adheres to the contacting surface or extends into the water layer.

When the ballast tank is drained, the water pulls some of the corrosion-inhibiting molecules oriented at the oil-water interface into the ocean. When particles of silt and sand are present in the water, they are wetted by the flotation oil and retain these surface-active compounds when they settle to the bottom of the ballast tanks or are carried into the ocean. As fresh rust forms or old rust scale falls away, more corrosion-inhibiting molecules are lost. Thus, flotation oils inside ballast tanks can lose their corrosion-inhibiting character.

Initial studies at this Laboratory[1, 2, 3] had shown that both proprietary and laboratory-prepared floating oils containing surface-active agents and rust-retarding compounds reduced the corrosion losses of steel test specimens to a low amount, at least for the duration of the test period.

In-service field studies had shown that flotation-type corrosion-preventive material in use inside ballast tanks gradually lose their protective ability.[3, 4, 5, 6] Properly prepared and exposed steel test specimens had been shown to be an adequate measure of corrosion in cargo tanks.[7]

During the study of flotation-type protective oils, it was found that a rust-retarding oil, conforming to MIL-C-17936, had lost much of its inhibitive properties after 2 years of use inside the ballast tanks of the USS AFDL-20.[3] This property of an inhibitive oil had been reported previously.[8]

A study of the corrosion occurring on steel test specimens exposed in the ballast tank of a floating drydock in Guam had shown that corrosion of these specimens was reduced from about 0.020 ipy (inches penetration per year) to about 0.001 ipy by a flotation-type oil conforming to MIL-R-21006.[4] This test extended over a period of 3 years. MIL-R-21006* replaced MIL-C-17936 in 1957.

TESTS OF USED RUST-RETARDING COMPOUNDS

A request was sent to the command of 42 floating drydocks for 1-gallon samples of rust-retarding flotation oil skimmed from the surface of the residual water in a ballast tank. It was further requested that a tag be attached to the container of used flotation oil giving the following data:

1. Drydock designation and location
2. Name of flotation oil
3. Date oil was first added to drydock
4. Date, name, and approximate percentage of fresh oil added at each replenishing.

Although 34 samples were received from the drydocks, only 21 were samples of rust-retarding, flotation-type, ballast-tank preservatives. These oils were subjected to the simulated ballast-tank testing procedure of MIL-R-21006. The Appendix gives in tabular form the drydocks contacted, those responding, the types of flotation oil, and the condition of the samples.

Procedure

The procedure called for the simulated ballast tank test to last for 12 weeks. One stipulation of the test is that the corrosion rate of the test panels must not exceed 0.005 ipy.

Both sandblasted and prerusted 4 x 2 x 1/8-inch steel test panels are specified for use in this simulated ballast-tank test. The prerusted panels were first sandblasted and then rusted inside a salt-spray cabinet to a gain in weight of 5 to 7 grams. As specified in this test, 3 sandblasted panels and 3 prerusted panels were suspended near the top of a 5-gallon pail, and similar panels were suspended near the bottom. This simulated ballast tank was filled with synthetic sea water to wet the panels. The

* Military Specification, Rust Retarding Compounds, Flotation Type, Ballast Tank, Protectives, MIL-R-21006 (SHIPS) of 30 August 1957.

water was then lowered to beneath the bottom group of panels. Four-hundred milliliters of preservative flotation oil was added to the surface of the water. The water level was periodically raised and lowered for the first 2 days of the test in order to thoroughly coat the test panels with the protective oil. On the third day, the oil was skimmed off the ballast water, and the ballast water was then completely replaced with fresh synthetic sea water. For the duration of the test, the sea water was periodically raised to submerge the test panels and lowered below the bottom panels.

After 12 weeks, the panels were removed from the simulated ballast tank, cleaned and weighed, and the corrosion losses were calculated.

Results

Thirteen of the 34 samples received were either practically clear sea water or non-fluid material. Twelve of the drydocks did not submit samples. The 21 usable samples came from 17 drydocks (see Appendix). All of the 21 samples of used oil failed to protect the prerusted test panels within the specified 0.005 ipy (see Table 1). However, 14 of the used flotation oils did protect the sandblasted test panels satisfactorily for the 12-week test period. Sandblasted steel generally receives better protection from oils and greases than does steel coated with rust.[3,4,8,9] Of these 14 samples of used flotation oil, all had been replenished with fresh oil within a year or less.

In three instances, replenishment with fresh oil within the previous 6 months had failed to improve the protective property of the flotation oil sufficiently to meet the requirements of the MIL-R-21006 testing procedure for protecting sandblasted steel. In no instance did the replenishment increase the concentration of corrosion inhibitors sufficiently to protect the prerusted steel test specimens. However, in five instances where the oil was replenished in large amounts or shortly before the sample was obtained, the corrosion rate of the prerusted steel panels was reduced to 0.008 ipy. It was noted that in one case (AFDL-16), a 6-month-old charge of flotation protective oil had lost its protective property to the extent that neither prerusted nor sandblasted steel test panels were protected to 0.008 ipy during the 12-week test.

A sample of fresh, unused flotation oil, Eureka Fluid Film 220/221, was used as a control. This oil protected the prerusted and the sandblasted steel test specimens within the requirements of the MIL-SPEC. The test method imposed a severe corrosion rate of 0.044 ipy for unprotected prerusted steel test specimens and of 0.028 ipy for the unprotected sandblasted steel specimens. These corrosion rates are more than double the average corrosion rates found in overhead areas of a

drydock at Guam.[4] The fresh Eureka Fluid Film 220/221 reduced these corrosion rates by about 90 percent for prerusted steel and by about 96 percent for sandblasted steel during the 12-week test period. The corrosion rate of 0.008 ipy for flotation oils in use inside a drydock for 1 year or less (Table I) showed the oils to have a residual capacity for about an 80 percent reduction in the corrosion rate of the prerusted steel. This capability of a used oil, coupled with the corrosion-inhibiting property initially imparted to the steel surfaces inside the ballast tanks at the time of application of the oil as new material, is considered indicative of satisfactory protection to the oil-coated areas of these drydocks at the time the sample was taken.

Those oils which were not replenished by nearly 100 percent each year did not give a high percentage of protection.

DISCUSSION

The results of this survey and study show that within a period of 1 year, the flotation oils inside a ballast tank of a floating drydock usually retained sufficient amounts of the surface-active components to protect <u>sandblasted</u> steel specimens satisfactorily throughout the 12-week period of the test. But the ability of this oil to penetrate freshly rusted surfaces and coat the underlying steel surface was not sufficient to give protection to <u>prerusted</u> steel specimens within the requirements of the MIL-SPEC. However, these oils did give the prerusted specimens a protection of about 80 percent. As stated before, this residual capacity is considered sufficient to indicate that satisfactory protection was in effect inside these drydocks at the time of sampling.

Observations made during field inspection of ballast tanks have shown that although the residual ballast water in the tanks was covered with flotation oil, large areas of the steel overhead were not oil-coated and were badly rusted.[4] Unretarded corrosion rate in these areas was found to be 0.020 ipy or more.[4]

CONCLUSIONS

From this study, the following conclusions were made:

1. Rust-retarding, flotation-type, ballast-tank preservatives will not meet the MIL-SPEC requirements after a few months' service inside the ballast tank of a floating drydock.

2. With suitable replenishment (approximately 100 percent per year), rust-retarding, flotation-type oils will reduce corrosion by better than 80 percent to all ballast-tank surfaces coated.

3. Because of improper use or maintenance of these oils, only 15 percent of the drydocks submitting samples were receiving satisfactory protection of their ballast tanks.

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Table I. Corrosion Losses

Drydock	Compound	Years in Use	Replenishment %	Replenishment Time Since	Corrosion Loss (ipy)[1] Prerusted	Corrosion Loss (ipy)[1] Sandblasted
AFDL-1-(a)	NO-OX-ID 519 "A" Special	1.5	1.5	6 mo	0.014	0.002
AFDL-1-(b)	Corrosion Battler A/B	1.0	30	1 mo	0.008	0.001
AFDL-1-(c)	Yosemite 610/610 A	1.5	20	1 mo	0.016	0.011
AFDL-1-(d)	Corrosion Battler A/B	1.5	40	1 mo	0.008	0.001
AFDL-5	Yosemite 610/610 A	2.0	50	1 yr	0.012	0.002
AFDL-6	Yosemite 610/610 A	1.0	10	4 mo	0.019	0.002
AFDL-9	Yosemite 610/610 A	4.0	33	6 mo	0.013	0.001
AFDL-16	Floatcoat	0.5	0	6 mo	0.014	0.006
AFDL-27	Floatcoat	0.25	0	3 mo	0.012	0.004
ARD-12	Corrosion Battler A/B	2.0	0	—	0.010	0.004
ARD-14	Yosemite 610/610 A	2.5	33	1 yr	0.012	0.001
ARD-23	Corrosion Battler HFC	0.25	0	3 mo	0.008	0.001
ARD-29	Floatcoat	1.5	0	—	0.015	0.011
ARD-30-(a)	Yosemite 610/610 A	3.0	75	6 mo	0.028	0.003
ARD-30-(b)	Tricon	0.33	0	4 mo	0.008	0.004
AFDM-4	Floatcoat	4.0	50	6 mo	0.018	0.014
AFDM-5	Yosemite 610	4.0	100	1 yr	0.008	0.001
AFDM-6	Floatcoat	4.0	100	1 mo	0.009	0.008
YFD-70	Yosemite 610/610 A/615	1.0	20	6 mo	0.009	0.001
YFD-71	Yosemite 610/610 A	4.0	40	2 yr	0.020	0.029
Controls						
Eureka Fluid Film 220/221 fresh un-used oil					0.004	0.001
Uncoated steel panels					0.044	0.028

1/ Inches penetration per year

Appendix

SAMPLES OF BALLAST-TANK PRESERVATIVES RECEIVED FROM DRYDOCKS

Drydock	Flotation Oil	Remarks
AFDL-1-(a)	NO-OX-ID 519 "A" Special	viscous, gas pressure
AFDL-1-(b)	Corrosion Battler A/B	fluid, H_2S odor
AFDL-1-(c)	Yosemite 610/610 A	fluid
AFDL-1-(d)	Yosemite 610/610 A and Corrosion Battler A/B	viscous, 3/4 water layer
AFDL-5	Yosemite 610/610 A	viscous, gas pressure, rust scale, 1/2 water layer
AFDL-6	Yosemite 610/610 A	fluid
AFDL-8	No sample	—
AFDL-9	Yosemite 610/610 A	very viscous
AFDL-15	No sample	—
AFDL-16	Floatcoat	fluid
AFDL-18	Corrosion Battler A/B	not fluid, H_2S odor
AFDL-26	No sample	—
AFDL-27	Floatcoat	fluid
AFDL-28	No sample	in overhaul
AFDL-29	No sample	—
AFDL-30	No sample	—
AFDL-31	Corrosion Battler A/B	not fluid, lower half grease-rust mass, gas pressure
ARD-7	Yosemite 610/610 A	1 gallon of clear sea water
ARD-11	Yosemite 610/610 A	1 gallon of clear sea water
ARD-12	Corrosion Battler A/B	fluid, H_2S odor, 1/3 water layer
ARD-14	Yosemite 610/610 A	very viscous

Drydock	Flotation Oil	Remarks
ARD-15	Corrosion Battler A/B	fluid, H_2S odor
ARD-16	Corrosion Battler A/B	1 gallon of sea water plus a trace of oil
ARD-17	No sample	in overhaul
ARD-18	Corrosion Battler G	not fluid
ARD-23	Corrosion Battler HFC	fluid, H_2S odor, 1/4 water layer
ARD-26	No sample	in overhaul
ARD-29	Floatcoat	fluid, 3/4 water layer
ARD-30	Yosemite 610/610 A	fluid, 3/4 water layer
ARD-32	Yosemite 610/610 A	1 gallon of clear sea water
AFDM-1	Yosemite 610/610 A	not fluid
AFDM-2	None	a bitumastic coating in tanks
AFDM-3	Yosemite 610/610 A	in overhaul
AFDM-4-(a)	Floatcoat	fluid, 3/4 water layer
AFDM-4-(b)	Yosemite 610/610 A	not fluid, gas pressure, garbage odor
AFDM-5	Yosemite 610	viscous, gas pressure, H_2S odor
AFDM-6	Floatcoat	fluid
AFDM-7	Unknown	not fluid, gas pressure
AFDM-9	Floatcoat	1 gallon of clear sea water
AFDM-10	No sample	—
YFD-7	Yosemite 610/610 A	not fluid
YFD-68	Yosemite 610/610 A	not fluid
YFD-69	No sample	on lease, scheduled to use Yosemite
YFD-70	Yosemite 610/610 A, replenished by 615	viscous
YFD-71	Yosemite 610/610 A	fluid
YFD-82	No sample	—

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13. ABSTRACT

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1. Rust retardation 2. Ballast tank preservatives I. Y-R007-08-04-401

Samples of used rust-retarding, flotation-type, ballast-tank preservatives were taken from 30 floating drydocks to analyze their corrosion-resisting properties. After a few months' service inside the ballast tank of a floating drydock, these oils were found to fail the MIL-SPEC requirements for rust retardation. It was found that, because of improper use of these oils, only about 20 percent of the drydocks were receiving as much as 80 percent reduction in corrosion.

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